

# Robot-Assisted Subtotal Pancreas-Preserving Duodenectomy

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## ABSTRACT

**Background:** Angiodysplasia of the duodenum is a rare disorder, often requiring surgical resection. Technical difficulties have made the use of the minimally invasive approach uncommon. Herein, we present a subtotal pancreas-preserving duodenectomy using robotic assistance.

**Methods:** The patient is a 60-y-old female with a long medical history including chronic gastrointestinal bleeding due to angiodysplasia with intermittent melena, and requiring multiples blood transfusions. A capsule endoscopy and double-balloon upper endoscopy showed angiectasis, which appeared to be limited to the third and fourth portion of the duodenum and the proximal loops of the jejunum. Despite multiple endoscopic cauterizations, the patient continued to require blood transfusion for several years. The patient underwent a robot-assisted subtotal pancreas-preserving duodenectomy.

**Results:** The operation lasted 420 min with minimal blood loss. The postoperative course was uneventful. The pathology report showed multiple small bowel mucosal and submucosal distorted and dilated vasculature, consistent with angiodysplasia. At 2-mo follow-up, the patient was totally asymptomatic. A barium swallow study showed contrast passed antegrade through the duodeno-jejunoscopy with no evidence of obstruction, stricture, or leakage.

**Conclusion:** The use of robotic assistance to perform a subtotal pancreas-preserving duodenectomy for the treatment of benign duodenal disease, such as angiodysplasia, is feasible and safe. The technical advantages include a high degree of freedom offered by the robotic instruments, as well as enhanced visualization, which allows for

precise microdissection and microsuture, thereby preserving the benefits of minimally invasive surgery. The use of robotic technology allows for a wider range of indications for minimally invasive surgery.

**Key Words:** Robotic surgery, Pancreas-preserving duodenectomy, Duodenojejunoscopy.

## INTRODUCTION

Gastrointestinal angiodysplasia is an important cause of gastrointestinal hemorrhage. The rate of gastrointestinal bleeding is reported to be 3% to 5% with a high percentage of cases that cease bleeding spontaneously.<sup>1</sup> Duodenal involvement, however, is very rare.<sup>2-5</sup> When patients are symptomatic, treatments include pharmacological agents and endoscopic procedures.<sup>6-11</sup> Interventional radiology<sup>12,13</sup> and surgical resection are considered as options only after conservative management has failed. Reports have shown as many as 12% of patients requiring surgical treatment.<sup>1</sup> The minimally invasive approach is not a common option, because it can be technically more difficult in these cases.

Herein, we present a case of multiple duodenal angiodysplasia extended to the first loops of the jejunum, requiring resection. To our knowledge, this is the first report of a robot-assisted, subtotal pancreas-preserving duodenectomy (third and fourth duodenal portion) with resection of the first loops of the jejunum, using the da Vinci Surgical System.

## MATERIALS AND METHODS

The patient was a 60-y-old female with a long medical history of chronic obstructive pulmonary disease (COPD), peripheral vascular disease, seizure disorder, schizophrenia, anxiety, medial cerebral artery aneurysm (treated by clipping), stroke, depression, and colon cancer which required a right hemicolectomy. Additionally, the patient had a history of gastrointestinal (GI) angiodysplasia with chronic GI bleeds and intermittent melena, requiring blood transfusions approximately every week during the previous 5 y. At the time of her visit, she was taking

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The authors would like to thank Dr. Luca Arru for the drawing in Figure 3.

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DOI: 10.4293/108680812X13517013316591

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multiple medications including inhaled  $\beta$ -blockers on demand, acetaminophen, escitalopram, ferrous sulfate, fluphenazine decanoate, lansoprazole, levetiracetam, lorazepam, metoprolol, rabeprazole, simvastatin and a multivitamin, noncoagulation-altering medications.

All prior workups, including endoscopy, angiography, and red cell scans, were inconclusive. Reports of a lower GI study were negative, and capsule endoscopy showed angiectasis, which appeared to be limited to the third and fourth portions of the duodenum and the proximal loops of the jejunum. On 3 separate occasions, the patient underwent a double-balloon upper endoscopy, which confirmed multiple small angiectasias in the distal duodenum and jejunum. These were later cauterized. Despite these interventions, the patient continued to require blood transfusions for several years, transfusing more than 500 U of blood during this time period.

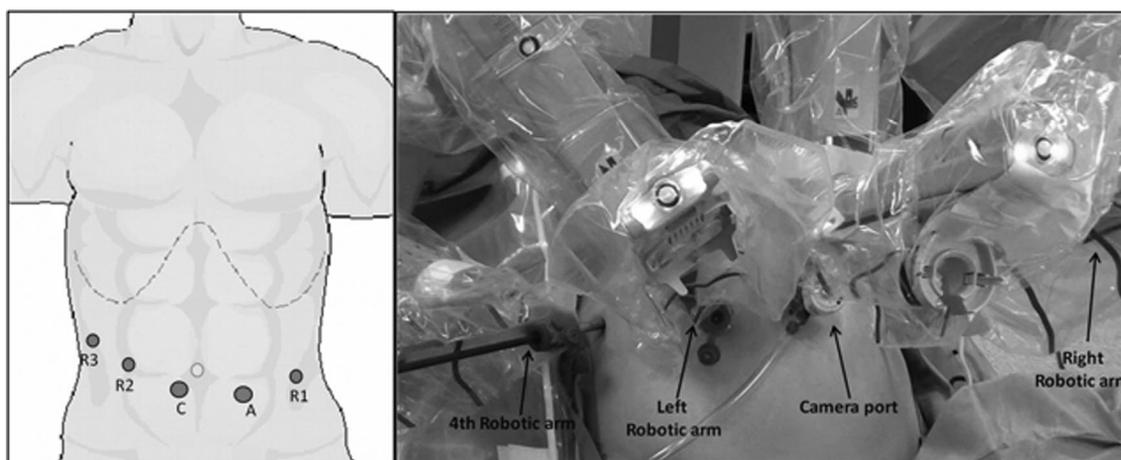
The patient was referred for surgical evaluation and possible resection of the involved bowel segment. On her last admission, the patient underwent a final double-balloon endoscopy, at which time an India ink tattoo was made several centimeters beyond the last angiectasias to serve as the distal margin. The preoperative workup showed normal functionality of cardiorespiratory system and no contraindication for surgery. The proposed direction for this case was to first attempt a minimally invasive approach with robot assistance. The advantages of the robot would provide a better dissection and detachment of the pancreas from the duodenum to preserve the pancreas.

### Surgical Technique

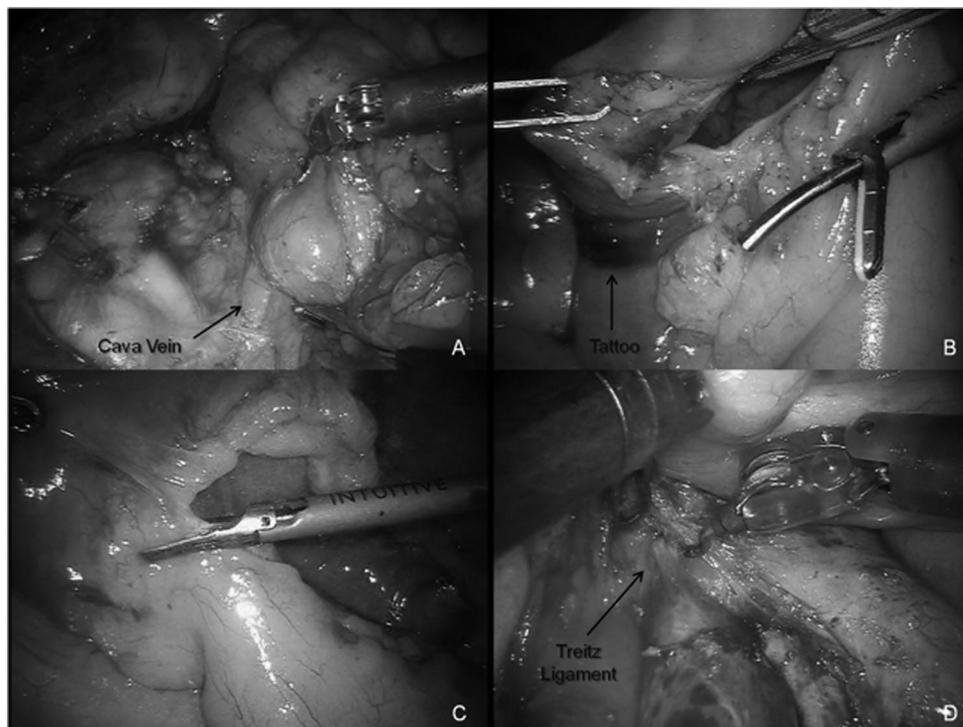
A totally robot-assisted approach was performed. The patient was positioned supine in a split-leg slight reverse

Trendelenburg position with arms tucked to the sides. She was monitored with electrocardiography, Foley catheter, nasogastric tube, arterial line, and venous line during the entire procedure. Lower limbs were protected with intermittent compression devices. The assistant surgeon stood in between the patient's legs. A Veress needle was placed to achieve pneumoperitoneum and the trocars were inserted. There were massive adhesions and massive omentum and bowel adhesions, which were taken down laparoscopically. The camera port was placed slightly lower and to the right of the umbilicus (**Figure 1**). The trocars were then inserted. For the left arm of the robot, a robotic trocar was placed in the right flank of the abdomen at the midclavicular line. For the right arm of the robot, an 8-mm trocar was inserted in the left flank at the left midclavicular line. For the third arm, a trocar was placed in the midabdomen at the level of the anterior axillary line. An additional 12-mm laparoscopic trocar was placed in between the left robotic trocar and the camera port as the first assistant's port. The robot was brought cranially and docked to the robotic trocars (**Figure 1**).

The procedure began with mobilization of the right colonic flexure and transverse colon to expose the second and third portions of the duodenum. This was done using the monopolar hook and the Harmonic device (Ethicon Endo-Surgery, Inc; Cincinnati, OH). A Kocher maneuver was then performed to assess the duodenum and pancreas (**Figure 2A**). The transverse colon was then retracted upward and the ligament of Treitz was exposed. The Indian ink tattoo placed earlier on the jejunum was identified approximately 1 m distally from the Treitz (**Figure 2B**), demarcating the distal portion of the diseased segment of the bowel. Using an Endo GIA (Covidien, Norwalk CT) stapler, the small bowel was tran-



**Figure 1.** Trocar placement; (C) camera port; (A) assistant trocar; (R) robotic trocars.



**Figure 2.** Distal duodenectomy extended to first loops of jejunum. (A) Kocher maneuver; (B) tattoo identifications and transection at distal margin; (C) jejunum dissection; (D) Treitz ligament dissection.

sected distally to the tattoo. Using the Harmonic device (Ethicon Endo-Surgery Inc, Cincinnati OH), the proximal jejunum was dissected, detaching it from the mesentery (**Figure 2C**). The ligament of Treitz (**Figure 2D**) was then taken down and the duodenojejunal flexure and first jejunal loops were retracted on the right side of the transmesocolon posteriorly to the superior mesenteric vessels. The third portion of the duodenum was then detached from the uncinate process and ventral portion of the head of the pancreas using a monopolar hook. At the same time, an infusion of Octreotide was started to decrease chances of pancreatitis during the procedure. During this step, 2 diverticuloma were detected on the wall of the third portion of the duodenum. They were approximately 2.5cm and 1cm in size.

The duodenum was transected proximal to the inferior duodenal flexure by using a stapler device, and the proximal stump of the duodenum was sutured using 2-0 polypropylene. The proximal margin was determined through the preoperative endoscopy where the lesions were identified beginning from the third portion of duodenum. In the final step, the proximal stump of the jejunum was brought to the side of the second portion of the duodenum and a side-to-side duodenojejunostomy (**Figure 3**) was created using an Endo GIA (Covidien, Norwalk CT) stapler device. The enterotomy was hand-sewn with 3-0

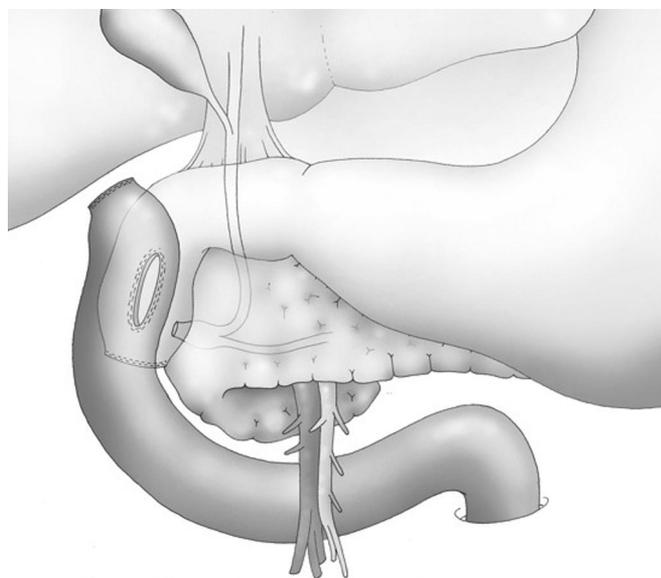
Polydioxanone (PDS II suture) and polypropylene suture. A drain was not needed. The specimen was extracted through an enlarged port site and sent for permanent pathology. The robot was undocked and the wounds were closed.

## RESULTS

The operation lasted 420 min with minimal blood loss. The postoperative course was uneventful, and the patient tolerated her diet well with no complications. The pathology report showed multiple small-bowel mucosal and submucosal distorted and dilated vasculature, consistent with angiodysplasia, and 2 diverticula were identified in the specimen. At 2-mo follow-up, the patient was having regular bowel movements, no dark stools, and had no further need for blood transfusions. Her hemoglobin was 10.9%. Additionally, a barium swallow study (**Figure 4**) showed contrast passed antegrade through the duodenojejunostomy with no evidence of obstruction, stricture, or leakage.

## DISCUSSION

Angiodysplasia of the duodenum is a rare condition.<sup>2,3,14</sup> It can be challenging not only diagnostically but also therapeutically, often requiring surgical treatment.<sup>1,5</sup> To date,



**Figure 3.** Duodenojejunal anastomosis.

very few cases have been reported.<sup>14</sup> One reason may be that visual and/or tactile intraoperative identification of these lesions can be very difficult. During laparoscopic surgery in particular, a type of indirect haptic feedback can be obtained.<sup>15</sup> With the robot, this type of feedback is not possible,<sup>16,17</sup> and its positioning (cranially) is hindering access to the patient, as in many upper GI procedures.

To provide better identification of the lesions, an intraoperative endoscopy can be useful to help pinpoint the location.<sup>18–20</sup> The use of a preoperative endoscopy with tattooing of the lesions or margin of the lesion is also highly recommended.<sup>21,22</sup>

In our patient, angioembolization was not an optimal therapeutic option, because the patient did not have acute bleeding, as this procedure requires at least 0.5 mL/min of active bleeding to localize the lesions.

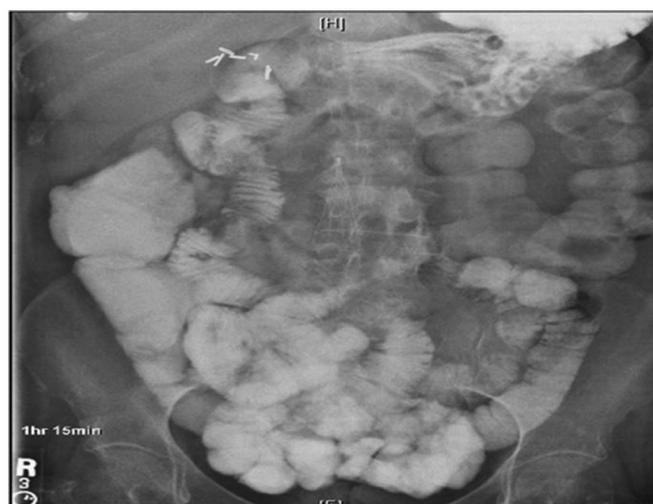
The surgical management of duodenal disease is a constant challenge for the surgeon. This is due not only to the likelihood of postoperative complications (fistulas, sepsis, focal pancreatitis, and others)<sup>23–26</sup> but also to the reconstruction phase, because often a duodenopancreatectomy is required in order to resolve pathologies involving the first and second duodenal portions. For lesions involving the third and fourth portions of the duodenum, a distal duodenectomy resection can be performed, although this type of minimally invasive approach has only been reported twice in the literature,<sup>27,28</sup> once for adenocarcinoma of the distal duodenum and the second for an

ulcerating stenosis of the duodenum and proximal jejunum, related to nonsteroidal anti-inflammatory drug use.

To our knowledge, there are no reported cases of distal duodenal resection using the minimally invasive approach in angiodysplasia of the duodenum. This is the first report of a robot-assisted, subtotal pancreas-preserving duodenectomy (third and fourth portions of the duodenum), extended to the first jejunal loops.

Although in our case the patient had COPD and this condition may represent a risk because of the need to perform pneumoperitoneum, this can be very well controlled since capnography is used on a regular basis in minimally invasive procedures. A main concern in these patients is to avoid subcutaneous emphysema that could increase their partial arterial pressure of carbon dioxide. In case this should happen, it can be well controlled with adequate ventilation. Conversion to open surgery is always a possibility, should this be required by unexpected complications.

The advantages of using the robotic system in general surgery have been well established in the literature.<sup>29–34</sup> It is important that when possible, and without increasing the risk for patients, a minimally invasive approach be attempted due to better results and fewer complications, as compared with the standard open procedure. The minimally invasive approach also allows for better postoperative respiratory function, thus avoiding the immobility of the chest wall caused by pain of the surgical wound. This is especially important in our case in which the patient will benefit more postoperatively for being a COPD patient. The robotic approach allows for some technical



**Figure 4.** Postoperative contrast swallow study.

advantages over the pure laparoscopic approach as well. The microdissection of the uncinate process of the pancreas and the possibility of microsuturing the smallest vessels connected to the pancreas allow for a better duodenal mobilization with a pancreatic-preserving technique. Additionally, we have found that the monopolar hook in the right robotic arm and the fenestrated bipolar in the left arm provide the best combination for simultaneous dissection and coagulation. The monopolar hook is an essential tool that can be used both for cauterization and as a right angle, resulting in the complete Kocherization of the duodenum and Treitz dissection. The use of the fourth arm allows the surgeon to obtain a precise and static retraction and exposure. Finally, the 3-dimensional vision with magnification provides enhanced visualization of the microanatomical structures.

In our case, during the final stage of the operation, a duodenojejunostomy was performed using a stapler. This can be done using a hand-sewn technique and can precisely and comfortably be performed using robotic technology, as has been described previously.<sup>35</sup> However, this represents a challenge in laparoscopy, requiring advanced laparoscopic skills.

## CONCLUSION

Robot-assisted, subtotal pancreas-preserving duodenectomy is feasible and safe, with technical advantages including a high degree of freedom of the robotic instruments and the ergonomic advantages that are provided to the surgeon. The fourth arm, which allows stable retraction and exposure, and the enhanced vision allowing precise microdissection and microsuturing are additional benefits.

After more than 10 y from the introduction of robotic technology in surgery, it is exciting to continue to witness an ever-increasing range of indications for minimally invasive surgery.

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